CLAIMS

WE CLAIM:

1. A soft-reference three conductor magnetic memory storage device comprising:

an electrically conductive first sense/write conductor;

an electrically conductive second sense conductor;

a soft-reference spin valve memory (SVM) cell in electrical contact with and located between the first sense/write conductor and the second sense conductor, the SVM cell comprising a material with an alterable orientation of magnetization; and

an electrically conductive third write column substantially proximate to and electrically isolated from the second sense conductor.

2. The magnetic memory device of claim 1, wherein each SVM cell includes:

at least one ferromagnetic data layer characterized by an alterable orientation of magnetization;

an intermediate layer in contact with the at least one ferromagnetic data layer; and

at least one ferromagnetic soft-reference layer in contact with the intermediate layer, opposite from the at least one ferromagnetic data layer, the at least one ferromagnetic soft-reference layer having a non-pinned orientation of magnetization and lower coercivity than the at least one ferromagnetic data layer.

3. The magnetic memory device of claim 2, wherein the SVM cell is operable during a read operation such that the at least one ferromagnetic soft-reference layer is oriented-on-the-fly to a desired orientation by a sense magnetic field generated by at least one sense current flowing in the third write column conductor, the magnetic field being insufficient to affect the orientation of the at least one ferromagnetic data layer of the SVM cell; and

wherein the SVM cell is operable during a write operation such that the combined write magnetic field generated by a write current flowing in the first sense/write conductor and a write current flowing in the third write column conductor, the combined magnetic field sufficient to orient the at least one ferromagnetic data layer.

4. The magnetic memory device of claim 2, wherein the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer are each further characterized as having a hard axis and an easy axis, the easy axis of the data layer being substantially parallel to the easy axis of the at least one ferromagnetic soft-reference layer, and the third write column conductor being substantially transverse to the easy axis of the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer.

5. A soft-reference three conductor magnetic memory storage device comprising:

a plurality of parallel electrically conductive first sense/write conductors;

a plurality of parallel electrically conductive second sense conductors crossing the first conductors, each thereby forming a cross-point array with a plurality of intersections;

a plurality of soft-reference spin valve memory (SVM) cells, each cell in electrical contact with and located at an intersection between a first sense/write conductor and a second sense conductor, the memory cells comprising a material with an alterable orientation of magnetization; and

a plurality of parallel electrically conductive third write column conductors substantially proximate to and electrically isolated from the second sense conductors.

6. The magnetic memory device of claim 5, wherein the third write column conductors are electrically isolated from the second sense conductors by physical space.

7. The magnetic memory device of claim 5, wherein the third write column conductors are electrically isolated from the second sense conductors by a dielectric therebetween.

8. The magnetic memory device of claim 5, wherein the third write column conductors are substantially parallel to the second sense conductors.

9. The magnetic memory device of claim 5, wherein the third write column conductors are substantially surrounded by a ferromagnetic cladding.

10. The magnetic memory device of claim 5, wherein the first sense/write conductors are substantially surrounded by a ferromagnetic cladding.

11. The magnetic memory device of claim 5, wherein each SVM memory cell includes:

at least one ferromagnetic data layer characterized by an alterable orientation of

magnetization;

an intermediate layer in contact with the data layer; and

at least one ferromagnetic soft-reference layer in contact with the intermediate layer, opposite from the data layer, the soft-reference layer having a non-pinned orientation of magnetization and lower coercivity than the data layer.

12. The magnetic memory device of claim 11, wherein the SVM cell is operable during a read operation such that the at least one ferromagnetic soft-reference layer of the given cell is oriented-on-the-fly to a desired orientation by a sense magnetic field generated by at least one sense current flowing in at least one third write column conductor crossing the selected cell, the magnetic field being insufficient to affect the orientation of the at least one ferromagnetic data layer of the selected SVM cell; and

wherein the SVM cell is operable during a write operation such that the combined write magnetic field generated by a write current flowing in a first sense/write conductor contacting the selected cell and a write current flowing in a third write column conductor crossing the selected cell, the combined magnetic field sufficient to orient the at least one ferromagnetic data layer.

13. The magnetic memory device of claim 11, wherein the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer are each further characterized as having a hard axis and an easy axis, the easy axis of the data layer being substantially parallel to the easy axis of the at least one ferromagnetic soft-reference layer, and the third write column conductor being substantially transverse to the easy axis of the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer.

14. A soft-reference three conductor magnetic memory (SVM) cell comprising:

at least one ferromagnetic data layer characterized by an alterable orientation of magnetization;

an intermediate layer in contact with the data layer;

at least one ferromagnetic soft-reference layer in contact with the intermediate layer, opposite from the data layer, the soft-reference layer having a non-pinned orientation of magnetization and lower coercivity than the data layer;

at least one first sense/write conductor in electrical contact with the data layer, opposite from the intermediate layer;

at least one second sense conductor in electrical contact with the soft-reference layer, opposite from the intermediate layer; and

at least one third write column conductor substantially proximate to and electrically isolated from the second sense conductor.

15. The magnetic memory device of claim 14, wherein the SVM cell is operable during a read operation such that the at least one ferromagnetic soft-reference layer of the selected cell is oriented-on-the-fly to a desired orientation by a sense magnetic field generated by at least one sense current flowing in at least one third write column conductor crossing the selected cell, the magnetic field being insufficient to affect the orientation of the at least one ferromagnetic data layer of the selected SVM cell; and

wherein the SVM cell is operable during a write operation such that the combined write magnetic field generated by a write current flowing in a first sense/write conductor contacting the selected cell SVM and a write current flowing in a third write column conductor crossing the selected SVM cell, the combined magnetic field sufficient to orient the at least one ferromagnetic data layer.

16. The magnetic memory device of claim 14, wherein the first conductor is substantially transverse to the second conductor.

17. The magnetic memory device of claim 14, wherein the third write column conductor is substantially parallel to the second sense conductor.

18. The magnetic memory device of claim 14, wherein the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer are each further characterized as having a hard axis and an easy axis, the easy axis of the at least one ferromagnetic data layer being substantially parallel to the easy axis of the at least one ferromagnetic soft-reference layer, and the third write column conductor being substantially transverse to the easy axis of the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer.

19. A soft-reference three conductor magnetic memory cell comprising:

at least one ferromagnetic data layer characterized by an alterable orientation of magnetization;

an intermediate layer in contact with the at least one ferromagnetic data layer;

at least one ferromagnetic soft-reference layer in contact with the intermediate layer, opposite from the at least one ferromagnetic data layer, the at least one ferromagnetic soft-reference layer having a non-pinned orientation of magnetization and lower coercivity than the at least one ferromagnetic data layer;

at least one first sense/write conductor in electrical contact with the at least one ferromagnetic soft-reference layer, opposite from the intermediate layer;

at least one second sense conductor in electrical contact with the at least one ferromagnetic data layer, opposite from the intermediate layer; and

at least one third write column conductor substantially proximate to and electrically isolated from the second sense conductor.

20. The magnetic memory device of claim 19, wherein the SVM cell is operable during a read operation such that the at least one ferromagnetic soft-reference layer of the selected cell is oriented-on-the-fly to a desired orientation by a sense magnetic field generated by at least one sense current flowing in at least one third write column conductor crossing the selected cell, the magnetic field being insufficient to affect the orientation of the at least one ferromagnetic data layer of the selected cell; and

wherein the SVM cell is operable during a write operation such that the combined write magnetic field generated by a write current flowing in a first sense/write conductor contacting the selected cell and a write current flowing in a third write column conductor crossing the selected cell, the combined magnetic field sufficient to orient the at least one ferromagnetic data layer.

21. The magnetic memory device of claim 19, wherein the first conductor is substantially transverse to the second conductor.

22. The magnetic memory device of claim 19, wherein the third write column conductor is substantially parallel to the second sense conductor.

23. The magnetic memory device of claim 19, wherein the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer are each further characterized as having a hard axis and an easy axis, the easy axis of the at least one ferromagnetic data layer being substantially parallel to the easy axis of the at least one ferromagnetic soft-reference layer, and the third write column conductor being substantially transverse to the easy axis of the at least one ferromagnetic data layer and the at least one ferromagnetic soft-reference layer.

24. A method of self referenced non-destructively determining a data value in a magnetic memory storage device having a plurality of soft-reference layer three conductor SVM cells, each cell including at least one data layer and at least one soft-reference layer, the method including:

selecting a given SVM cell in electrical contact with a given first sense/write conductor, a given second sense conductor, and substantially proximate to and electrically isolated from a third write column conductor;

providing an initial field current to the third write column conductor; the initial current generating an initial sense magnetic field proximate to the given SVM cell;

orienting-on-the-fly the at least one soft-reference layer of the given SVM cell in orientation with the initial sense magnetic field;

providing an initial sense current by the given first sense/write conductor and second sense conductor through the given SVM cell;

measuring an initial resistance value of the given SVM cell;

storing the initial resistance value;

providing a second known field current to the third write column conductor, the second known current generating an second known sense magnetic field orienting the at least one soft-reference layer in a second known orientation;

providing a second sense current by the given first sense/write conductor and second sense conductor through the given SVM cell;

storing the second resistance value as a reference resistance;

comparing the initial resistance value to the reference resistance value; and

returning a logic level associated with the compared state.

25. The method of claim 24, wherein the sense magnetic fields do not affect the at least one data layer.

26. The method of claim 24, wherein the second known field current flows in an opposite direction to the initial field current.

27. The method of claim 24, wherein the magnitude of the initial field current is substantially about zero.

28. The method of claim 24, wherein the initial resistance value is measured when the orientation of the at least one soft-reference layer is anti-parallel to the at least one data layer.

29. The method of claim 24, wherein the method is repeated more than once.

30. The method of claim 24, wherein the at least one soft-reference layer is characterized as having a hard axis and an easy axis, the initial and second magnetic fields being in line with the easy axis.

31. A computer system comprising:

a main board;

at least one central processing unit (CPU) coupled to the main board;

at least one memory store joined to the CPU by the main board, the memory store including:

a plurality of parallel electrically conductive first sense/write conductors;

a plurality of parallel electrically conductive second sense conductors crossing the first conductors, each thereby forming a cross-point array with a plurality of intersections;

a plurality of soft-reference SVM cells, each cell in electrical contact with and located at an intersection between a first conductor and a second conductor, the memory cells including;

at least one ferromagnetic data layer characterized by an alterable orientation of magnetization;

an intermediate layer in contact with the at least one ferromagnetic data layer;

at least one ferromagnetic soft-reference layer in contact with the intermediate layer, opposite from the data layer, the at least one ferromagnetic soft-reference layer having a non-pinned orientation of magnetization and lower coercivity than the at least one ferromagnetic data layer; and

a plurality of parallel electrically conductive third write column conductors substantially proximate to and electrically isolated from the second sense conductors.

32. The magnetic memory device of claim 31, wherein the SVM cell is operable during a read operation such that the at least one ferromagnetic soft-reference layer of the selected SVM cell is oriented-on-the-fly to a desired orientation by a sense magnetic field generated by at least one sense current flowing in at least one third write column conductor crossing the selected SVM cell, the magnetic field being insufficient to affect the orientation of the at least one ferromagnetic data layer of the selected cell; and

wherein the SVM cell is operable during a write operation such that the combined write magnetic field generated by a write current flowing in a first sense/write conductor contacting the selected SVM cell and a write current flowing

in a third write column conductor crossing the selected SVM cell, the combined magnetic field sufficient to orient the at least one ferromagnetic data layer.